AMENDMENTS TO THE CLAIMS

The following is a complete, marked-up listing of revised claims with a status identifier in parenthesis, underlined text indicating insertions, and strike through and/or double-bracketed text indicating deletions.

LISTING OF CLAIMS

1. (Previously Presented) An apparatus for direct measurement of the channel state of an OFDM (Orthogonal Frequency Division Multiplexing) receiver comprising:

a de-mapping and pilot insertion unit which receives complex OFDM signals, performs de-mapping processing corresponding to data carriers, TPSC (Transmission Parameter Signaling Carriers) and one of CPC (Continual Pilot Carrier) and SPC (Scattered Pilot Carrier) of the complex OFDM signals, and outputs the de-mapped signals;

a subtraction unit which subtracts the complex OFDM signals from the de-mapped signals and outputs the subtracted values;

a squared Euclidean distance calculation unit which calculates a squared value of a signal for I (In-phase) and a squared value of a signal for Q (Quadrature) of output signals of the subtraction unit, and outputs a first error which is a sum of the squared values;

a non-recursive carrier filtering unit which delays the first error one carrier at a time, multiplies filtering coefficients by a present carrier value of the first error and multiple delayed carrier values, and outputs a second error which is a sum of the multiplied values;

a data carrier extraction unit which extracts and outputs an error corresponding to the data carrier from the second error;

a recursive symbol filtering unit which outputs a third error which averages the output error of the data carrier extraction unit and a previous symbol; and

a quantization unit which receives the third error, inverts the third error with non-linear transfer function relation, and outputs a CSI (Channel State Information) signal including quantized multiple bits.

2. (Original) The apparatus of claim 1, further comprising a total delay line, which delays and outputs the complex OFDM signals as much as the delay of the non-recursive carrier filtering unit.

3. (Original) The apparatus of claim 1, further comprising an adaptation unit, which estimates a correlation coefficient signal of two adjacent carriers using a signal corresponding to an inverse number of an SMCFR (Squared Magnitude of the Channel Frequency Response) and outputs filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal.

4. (Original) The apparatus of claim 1, wherein the de-mapping and pilot insertion unit comprises:

a QAM (Quadrature Amplitude Modulation) de-mapper which de-maps and outputs values belonging to the data carrier according to a QAM format;

a BPSK (Binary Phase Shift Keying) de-mapper which de-maps and outputs values belonging to the TPSC according to a BPSK format; and

a reference sequence generator which substitutes and outputs a sequence of real values for every carrier position corresponding to values belonging to at least one of the CPC and the SPC.

5. (Original) The apparatus of claim 1, wherein the subtraction unit comprises:

a first subtracter which subtracts and outputs the complex OFDM signal from a de-mapped signal of values belonging to the data carrier;

a second subtracter which subtracts and outputs the complex OFDM signal from a de-mapped signal of values belonging to the TPSC;

a third subtracter which subtracts and outputs the complex OFDM signal from a de-mapped signal of values belonging to one of the CPC and the SPC;

control logic which inputs a carrier number and a scattered pilot pattern signal, distinguishes the type of present carrier, and outputs a MUX control logic signal depending on whether the present carrier is the data carrier, the TPSC, or one of the CPC and the SPC; and

a MUX which selectively outputs one of the first subtracter output signal, the second subtracter output signal, and the third subtracter output signal in response to the MUX control logic signal.

6. (Original) The apparatus of claim 1, wherein the squared Euclidean distance calculation unit comprises:

an IQ signal selector which divides and outputs an output signal of the subtraction unit into a signal for I and a signal for Q;

a first square calculator which calculates and outputs a squared value of a signal for I;

a second square calculator which calculates and outputs a squared value of a signal for Q; and

an adder which outputs a first error which is a sum of the squared values.

7. (Original) The apparatus of claim 1, wherein the non-recursive carrier filtering unit comprises:

carrier delay lines which output delayed multiple carrier values by delaying the first error one carrier at a time;

coefficient multipliers which multiply and output the filtering coefficients by the present carrier value of the first error and the delayed multiple carrier values; and

adders which output a second error which is a sum of the squared values.

8. (Original) The apparatus of claim 1, wherein the recursive symbol filtering unit comprises:

an adder which outputs the third error which adds an output error of the data carrier extraction unit and a first recursive value;

a delay line which delays and outputs the third error by one symbol; and

a multiplier which outputs the first recursive value as a product of a forgetting factor and an output symbol of the delay line.

9. (Original) The apparatus of claim 1, wherein the quantization unit comprises:

comparators that compare the third error to reference levels which have an inverting and non-linear transfer function relation between the levels and the quantized number, output a

second logic state if the reference levels are higher than the third error, and output a first logic state if the reference levels are not higher than the third error; and

adders which add digital output values of the comparators and output a CSI signal of multiple bits.

10. (Original) The apparatus of claim 3, wherein the adaptation unit comprises:

a correlation calculation unit which estimates and outputs a correlation coefficient signal of two adjacent carriers using a signal corresponding to an inverse number of the SMCFR; and

a filter coefficient selection unit which outputs the filtering coefficients belonging to the filtering coefficient group selected according to the estimated correlation coefficient signal.

11. (Original) The apparatus of claim 10, wherein the correlation calculation unit comprises:

a first filter which inputs a signal corresponding to an inverse number of the SMCFR, and calculates and outputs an average value of the signal and a previous carrier;

a subtracter which subtracts and outputs the average value from an input signal corresponding to an inverse number of the SMCFR;

a delay line which delays an output signal of the subtracter by one carrier and outputs an adjacent carrier;

a multiplier which multiplies and outputs an output signal of the subtracter and the adjacent carrier; and

a second filter which inputs an output signal of the multiplier, calculates an average value of the output signal and a previous carrier, and outputs the estimated correlation coefficient signal.

12. (Original) The apparatus of claim 11, wherein the first filter comprises:

a first sub multiplier which multiplies and outputs a first time constant by a signal corresponding to an inverse number of the SMCFR;

a first sub adder which adds and outputs an output signal of the first sub multiplier and a second recursive value;

a first sub delay line which delays and outputs an output of the first sub adder by one carrier; and

a second sub multiplier which outputs the second recursive value by multiplying a second time constant by an output carrier of the first sub delay line.

13. (Original) The apparatus of claim 11, wherein the second filter comprises:

a second sub adder which outputs the estimated correlation coefficient signal by adding an output signal of the multiplier and a third recursive value;

a second sub delay line which delays and outputs the estimated correlation coefficient signal with one carrier; and

a third sub multiplier which outputs the third recursive value by multiplying a third time constant by an output carrier of the second sub delay line.

14. (Original) The apparatus of claim 10, wherein the filter coefficient selection unit comprises:

a filter selector which selects the filtering coefficient group according to the estimated correlation coefficient signal; and

a filter coefficients memory which stores filtering coefficients belonging to multiple filtering coefficient groups, and in response to the selection of a filtering coefficient group of the filter selector, outputs the filtering coefficients belonging to the selected filtering coefficient group.

15. (Previously Presented) A method of directly measuring the channel state of an OFDM receiver comprising:

receiving complex OFDM signals, performing de-mapping corresponding to respective values belonging to data carriers, TPSC, and CPC or SPC of the complex OFDM signals, and outputting the de-mapped signals;

subtracting the complex OFDM signals from the de-mapped signals, and outputting the subtracted values;

calculating a squared Euclidean distance by calculating a squared value of a signal for I and a squared value of a signal for Q of output signals of the subtracting, and outputting a first error which is a sum of the squared values;

filtering a non-recursive carrier by delaying the first error one carrier at a time, multiplying filtering coefficients by a present carrier value of the first error and multiple delayed carrier values, and outputting a second error which is a sum of the multiplied values;

extracting a data carrier by extracting and outputting an error corresponding to the data carrier from the second error;

filtering a recursive symbol by outputting a third error averaging the output error of the data carrier extracting step and a previous symbol; and

quantizing by receiving the third error, inverting the third error with a non-linear transfer function relation, and outputting a CSI signal including quantized multiple bits.

16. (Original) The method of claim 15, further comprising delaying the complex OFDM signals as much as the delay in the non-recursive carrier filtering and output.

17. (Original) The method of claim 15, further comprising estimating a correlation coefficient signal of two adjacent carriers using a signal corresponding to an inverse number of an SMCFR, and outputting the filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal.

18. (Original) The method of claim 15, wherein the de-mapping comprises:

de-mapping a QAM by de-mapping and outputting values belonging to the data carrier according to a QAM format;

de-mapping a BPSK by de-mapping and outputting values belonging to the TPSC according to a BPSK format; and

generating a reference sequence by substituting and outputting a sequence of real values at every carrier position corresponding to values belonging to one of the CPC and the SPC.

19. (Original) The method of claim 15, wherein the subtracting comprises:

first subtracting by subtracting and outputting the complex OFDM signal from a de-mapped signal of values belonging to the data carrier;

second subtracting by subtracting and outputting the complex OFDM signal from a de-mapped signal of values belonging to the TPSC;

third subtracting by subtracting and outputting the complex OFDM signal from a de-mapped signal of values belonging to one of the CPC and the SPC;

generating a control signal by inputting a carrier number and a scattered pilot pattern signal, determining the type of present carrier, and outputting MUX control logic signals depending on whether the present carrier is the data carrier, the TPSC, or one of the CPC and the SPC; and

multiplexing by selectively outputting one of an output signal of the first subtracting, an output signal of the second subtracting, and an output signal of the third subtracting in response to the MUX control logic signals.

20. (Original) The method of claim 15, wherein the squared Euclidean distance calculating comprises:

selecting an IQ signal by dividing and outputting the output signal of the subtracting into a signal for I and a signal for Q;

calculating a first square by calculating and outputting a squared value of a signal for I;

calculating a second square by calculating and outputting a squared value of a signal for Q; and

adding by outputting a first error which is a sum of the squared values.

21. (Original) The method of claim 15, wherein the non-recursive carrier filtering comprises:

delaying a carrier by outputting multiple delayed carrier values by delaying the first error one carrier at a time;

multiplying a coefficient by multiplying and outputting the filtering coefficients by the present carrier value of the first error and the delayed multiple carrier values; and

adding by outputting a second error which is a sum of the squared values.

22. (Original) The method of claim 15, wherein the recursive symbol filtering comprises:

adding an output error of the data carrier extracting and a first recursive value to output the third error;

delaying and outputting the third error by one symbol; and

multiplying a forgetting factor by an output symbol of the delaying to output the first recursive value.

23. (Original) The method of claim 15, wherein the quantizing comprises

comparing the third error to reference levels having the inverting and non-linear transfer function relation between the levels and the quantized number, outputting a second logic state if the reference levels are higher than the third error, and outputting a first logic state if the reference levels are not higher than the third error; and

adding digital output values of the comparing and outputting to obtain a CSI signal with the multiple bits.

24. (Original) The method of claim 17, wherein the adapting comprises:

calculating a correlation by estimating and outputting a correlation coefficient signal of two adjacent carriers using a signal corresponding to an inverse number of the SMCFR; and

selecting a filter coefficient by outputting the filtering coefficients belonging to the filtering coefficient group selected according to the estimated correlation coefficient signal.

25. (Original) The method of claim 24, wherein the correlation calculating comprises:

first filtering by inputting a signal corresponding to an inverse number of the SMCFR, and calculating and outputting an average value of the signal and a previous carrier;

subtracting and outputting the average value from an input signal corresponding to an inverse number of the SMCFR;

delaying an output signal of the subtracting by one carrier and outputting an adjacent carrier;

multiplying and outputting an output signal of the subtracting and the adjacent carrier; and

second filtering by inputting an output signal of the multiplying, calculating an average value of the output signal and a previous carrier, and outputting the estimated correlation coefficient signal.

26. (Original) The method of claim 25, wherein the first filtering comprises:

first sub multiplying by multiplying and outputting a first time constant by a signal corresponding to an inverse number of the SMCFR;

first sub adding by adding and outputting an output signal of the first sub multiplier and a second recursive value;

first sub delaying by delaying and outputting an output of the first sub adding by one carrier; and

second sub multiplying by outputting the second recursive value which multiplies a second time constant by an output carrier of the first sub delaying.

27. (Original) The method of claim 25, wherein the second filtering comprises:

second sub adding by outputting the estimated correlation coefficient signal which adds an output signal of the multiplying and a third recursive value;

second sub delaying by delaying and outputting the estimated correlation coefficient signal with one carrier; and

third sub multiplying by outputting the third recursive value which multiplies a third time constant by an output carrier of the second sub delaying.

28. (Original) The method of claim 24, wherein the filter coefficient selecting comprises:

selecting a filter by selecting the filtering coefficient group according to the estimated correlation coefficient signal; and

outputting a filter coefficients memory by storing filtering coefficients belonging to respective multiple filtering coefficient groups, and in response to the selection of a filtering coefficient group of the filter selecting, outputting the filtering coefficients belonging to the selected filtering coefficient group.

29. (Currently Amended) A non-recursive carrier filtering device for an apparatus for direct measurement of channel state of a receiver, comprising:

a delay unit which delays a first error by one or more carriers; and

a multiplier unit which multiplies filtering coefficients by a present carrier value and the one or more delayed carrier values and outputs a second error which is a sum of the multiplied values, wherein the filtering coefficients are output by an adaptation unit at the receiver using a signal corresponding to an inverse number of the squared magnitude of the channel frequency response and the second error signal is used to improve channel state estimation.

30. (Original) A squared Euclidean distance calculating device for an apparatus for direct measurement of a channel state of a receiver, comprising:

a calculating unit which receives a complex signal for a carrier and calculates a squared value of a signal for I (In-phase) and a squared value of a signal for Q (Quadrature) of the carrier and outputs an error, which is a sum of the squared values, wherein the error is used to improve channel state estimation.

31. (Currently Amended) An adaptation device for an apparatus for direct measurement of a channel state of a receiver, comprising:

an estimating unit which estimates a correlation coefficient signal of two or more adjacent carriers using a signal corresponding to an inverse number of ~~inverse~~ a squared magnitude of the channel frequency response at the receiver; and

a filter coefficient selection unit which outputs filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal, wherein the filtering coefficients are used to improve channel state estimation at the receiver.

32. (Currently Amended) An apparatus for direct measurement of a channel state of a receiver, comprising:

an adaptation device, at the receiver, including an estimating unit which estimates a correlation coefficient signal of two or more adjacent carriers using a signal corresponding to an inverse number of ~~inverse~~ a squared magnitude of the channel frequency response and a filter coefficient selection unit which outputs filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal;

a squared Euclidean distance calculating device including a calculating unit which receives a complex signal for a carrier and calculates a squared value of a signal for I (In-phase) and a squared value of a signal for Q (Quadrature) of the carrier and outputs a first error, which is a sum of the squared values; and

a non-recursive carrier filtering device, at the receiver, including a delay unit which delays the first error by one or more carriers and a multiplier unit which multiplies the filtering coefficients by a present carrier value and the one or more delayed carrier values and outputs a second error which is a sum of the multiplied values, wherein the second error signal is used to improve channel state estimation.

33. (Currently Amended) A method of non-recursively filtering a carrier for direct measurement of a channel state of a receiver, comprising:

delaying a first error by one or more carriers; and

multiplying filtering coefficients by a present carrier value and the one or more delayed carrier values and outputting a second error which is a sum of the multiplied values, wherein the filtering coefficients are output by an adaptation unit at the receiver using a signal corresponding

to an inverse number of the squared magnitude of the channel frequency response and the second error signal is used to improve channel state estimation.

34. (Original) A method of calculating a squared Euclidean distance for direct measurement of a channel state of a receiver, comprising:

receiving a complex signal for a carrier and calculating a squared value of a signal for I (In-phase) and a squared value of a signal for Q (Quadrature) of the carrier; and

outputting an error, which is a sum of the squared values, wherein the error is used to improve channel state estimation.

35. (Currently Amended) A method of performing adaptation for an apparatus for direct measurement of a channel state of a receiver, comprising:

estimating, at the receiver, a correlation coefficient signal of two or more adjacent carriers using a signal corresponding to an inverse number of ~~inverse~~ a squared magnitude of the channel frequency response; and

outputting, at the receiver, filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal, wherein the filtering coefficients are used to improve channel state estimation.

36. (Currently Amended) A method of directly measuring the channel state of an OFDM receiver comprising:

estimating, at the receiver, a correlation coefficient signal of two or more adjacent carriers using a signal corresponding to an inverse number of ~~inverse~~ a squared magnitude of the

channel frequency response;

outputting, at the receiver, filtering coefficients belonging to a filtering coefficient group selected according to the estimated correlation coefficient signal;

receiving a complex signal for a carrier and calculating a squared value of a signal for I (In-phase) and a squared value of a signal for Q (Quadrature) of the carrier and outputting the first error, which is a sum of the squared values;

delaying, at the receiver, a first error by one or more carriers and multiplying the filtering coefficients by a present carrier value and the one or more delayed carrier values; and

outputting a second error which is a sum of the multiplied values, wherein the second error signal is used to improve channel state estimation.